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The effect of humic acid levels and irrigation frequency on sunflower growth and yield.

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Abstract:

A field experiment was conducted during the 2024-2025 agricultural season, at the Research Station of the College of Agriculture, Al-Muthanna University, to study the effect of different levels of humic acids (humic and fulvic) and the frequency of irrigation on the growth and yield of sunflowers (variety Shamoos). The experiment was carried out using a split-plot design based on a randomized complete block design (RCBD) with three replicates. The study included three irrigation intervals (every 9, 11, and 13 days), and four levels of humic acids (0, 15, 30, and 45 kg ha-1). The results showed significant differences in the studied yield traits when humic acids were added (total seed number, 1000-seed weight, individual yield, and total yield).

Keywords: humic acid, irrigation frequency, sunflower, growth, yield.

Introduction:

Sunflower (*Helianthus annuus* L.) is among the most important oil crops in the world, it occupies a leading position among locally cultivated crops, and ranks third globally after soybeans and rapeseed [1]. Seeds of improved varieties of this crop are characterized by high oil content,

exceeding 49%, and also possess distinct taste qualities [2].

Iraq is suffering from an increasing scarcity of water resources and severe climate change, which negatively impacts plant growth [3]. With declining water resources, especially in the Tigris and Euphrates rivers, the importance of adopting scientific strategies aimed at improving water use efficiency in agriculture is highlighted. Managing irrigation intervals is one of the key strategies for achieving this goal [4].

Despite the effective role of mineral fertilizers in improving agricultural production, their high costs and negative impact on soil balance, due to their indiscriminate use, spurs the search for safer and less expensive alternatives. The importance of humic acids (humic and fulvic) is highlighted. They are considered fast-acting and harmless to humans and animals. They improve soil fertility and reduce the effects of environmental stress [5].

The effect of humic acids, especially humic and fulvic acids, is similar to that of plant hormones such as auxin and cytokinin, which contribute to stimulating pollen production and reducing ovule loss [6].

Materials and Methods:

Experimental Site and Field Design

A field experiment was conducted during the fall season (2024), at the Agricultural Research Station, College of Agriculture, Al-Muthanna University, to study the effect of humic and fulvic acid levels, and irrigation frequency on the yield components of sunflowers (Shamoos cultivar).

The experiment was conducted using a randomized complete block design (RCBD), according to a split-plot design with three replicates. The experiment included 36 experimental units representing all combinations of the study factors and their replicates. The main plots represented the number of irrigations, while the subplots represented the effect of humic acids. Organic fertilizer (a mixture of humic and fulvic) was added in two batches: the first after thinning, and the second after the emergence of the flower disc.

Experimental Factors

The first factor: Humic acids, symbolized by the symbol H, are added in two batches, the first after thinning and the second after the flower disc appears, these were 0, 15, 30 and 45 kg ha^{-1}.

The second factor: The number of irrigations, symbolized by the symbol W, which were 9, 11 and 13 irrigations.

Traits studied

Ten plants were randomly selected from the central line for the purpose of calculating the following traits:

Total number of seeds: The total number of seeds in the disc was calculated after discarding them, including empty and full seeds.

1000 seeds weight: This was calculated by 1000 seeds weighing from plants harvested from each experimental unit using a sensitive balance.

Individual yield: This was calculated by weighing the plants harvested from each experimental unit, then extracting the average per plant.

Total yield: This was calculated by multiplying the individual seed yield by the plant density, then converting it to tons ha^{-1}.

Results and discussion:

Table (1) shows the results of the statistical analysis, which showed that irrigation intervals and interaction had a non-significant effect on the total seed number trait, as for the effect of humic and fulvic acid, it had a significant effect.

The H2 concentration had the highest average (1269), compared to the H0 concentration, which recorded the lowest average (997). The increase in seed number is attributed to the effect of humic and fulvic acids in stimulating cell growth and development and chlorophyll, and increasing the proportion of sugars and amino acids. This leads to increased photosynthesis efficiency, food production, and consequently increased seed number [7].

Table 1. The effect of irrigation periods, humic acids, and the interaction between them on the total number of seeds.

Irrigation periods	Humic acids H0	H1	H2	H3	Mean
W1	971	1068	1231	1023	1073
W2	1007	1111	1242	1200	1140
W3	1013	1101	1334	1321	1192
Mean	997	1094	1269	1181	
L.S.D$_{0.05}$	W N.S		H 104.2		W*H N.S

Table (2) shows the results of the statistical analysis, which showed that there was an insignificant effect of irrigation periods and interaction on the weight of 1000 seeds, while the effect of humic and fulvic was significant.

The H2 concentration had the highest average (34.32 gm), compared to the H0 concentration, which recorded the lowest average (31.23 gm), and the H3 concentration, which recorded 31.57 gm. The increase in this trait when adding humic and fulvic acid is due to their effect in stimulating vegetative growth, which in turn stimulates photosynthesis in the leaves [1].

Table 2. The effect of irrigation periods, humic acids, and the interaction between them on the weight of 1000 seeds (gm).

Irrigation periods	Humic acids H0	H1	H2	H3	Mean
W1	31.97	34.99	34.60	32.22	33.44
W2	30.06	31.43	33.88	31.59	31.74
W3	31.65	33.22	34.48	30.91	32.57
Mean	31.23	33.22	34.32	31.57	
L.S.D$_{0.05}$	W N.S		H 1.429		W*H N.S

Table (3) shows the results of the statistical analysis, which showed that there was an insignificant effect of irrigation periods and interaction on the individual yield trait, while the effect of humic and fulvic was significant.

The H2 concentration had the highest average (43.25 gm plant^{-1}), compared to the H0 concentration, which recorded the lowest average (31.19 gm plant^{-1}), this may be due to the increased plant height, as well as the total seed number and 1000-seed weight [8].

Table 3. The effect of irrigation periods, humic acids and the interaction between them on the individual yield trait (gm plant^{-1}).

Irrigation periods	Humic acids H0	H1	H2	H3	Mean
W1	30.78	36.42	42.21	34.01	35.86
W2	31.21	35.21	41.98	43.44	37.96
W3	32.19	36.34	45.54	41.50	38.89
Mean	31.39	35.99	43.25	39.65	
L.S.D$_{0.05}$		W N.S		H 3.806	W*H N.S

Table (4) shows the results of the statistical analysis, which showed that

there was an insignificant effect of irrigation periods and interaction on the individual yield trait, while the effect of humic and fulvic was significant.

H2 concentration had the highest average (2.300 tons. ha^{-1}), compared to the H0 concentration, which recorded the lowest average (1.670 tons. ha^{-1}). This increase is due to the significant effect of humic and fulvic acid on individual yield, seed number per disc, and 1000-seed weight [9].

Table 4. The effect of irrigation periods, humic acids and their interaction on the total yield (tons. ha^{-1}).

Irrigation periods	Humic acids				Mean
	H0	H1	H2	H3	
W1	1.637	2.177	2.243	1.807	1.966
W2	1.660	1.873	2.233	2.310	2.019
W3	1.713	1.937	2.423	2.210	2.071
Mean	1.670	1.996	2.300	2.109	
$L.S.D_{0.05}$		W N.S		H 0.2339	W*H N.S

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